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A Bias in Skeletal Sexing

Karen Elizabeth Bone
University of Tennessee, Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Karen Elizabeth Bone entitled "A Bias in Skeletal Sexing." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Anthropology.

Lyle W. Konigsberg, Major Professor

We have read this thesis and recommend its acceptance:

William M. Bass, Walter E. Klippel

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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A BIAS IN SKELETAL SEXING

A Thesis

Presented for the

Master of Arts

Degree

The University of Tennessee, Knoxville

Karen Elizabeth Bone

May 1993

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Signature Karen Elizabeth Lowe

Date April 29, 1993

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ABSTRACT

Weiss (1973) documented the existence of a bias in skeletal sexing. Through the use of 43 archaeological populations he discerned that there was a bias towards males. The purpose of this research is to determine if the bias in skeletal sexing is still in existence today if not, to determine what factors may be explain the disappearance of biased sex ratios.

This study examines 49 archaeological site reports from North and South America. Four different factors were gathered from each site report because they are believed to affect sex ratios. Those four factors are: (1) when sites were excavated; (2) when demographic analysis was completed; (3) whether visual or metric techniques were utilized by examiners; and (4) the geographic region where the material was found.

Analysis of this data through the use of logistic regression showed that overall, since Weiss' article problems with biased sex assessments are not as prevalent today. Each of the four factors tested are believed to play some part in biased sex assessments. It is concluded here that anthropologists apparently have become more aware of the bias that exists and are employing sexing techniques with greater accuracy.

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CHAPTER 1

INTRODUCTION

Sex ratios are an important aspect of demographic research. At birth an expected norm for the sex ratio is approximately 1:1. As anthropologists examine adult sex ratios, they may differ from 1:1 for a variety of reasons. Some of those possibilities are: (1) differential mortality; (2) differential migration; (3) differential access to the mortuary site; (4) stochastic effect; and (5) biased assessments by those analyzing the skeletal material.

Sieff (1990) critiques current evolutionary explanations for bias in sex ratios. Sieff suggests that most evolutionary hypotheses are based on parental investment. Therefore, whichever sex, male or female, that will produce the greatest amount of return for the parents with the least amount of investment is where the parents will place most of their energy. Evolutionary theories concerning bias in sex ratios are important because anthropologists need to be able to explain whether or not the sex ratios of a given population are in a range of what are defined as expected norms. If the sex ratios do not meet expected norms, then there must be an avenue for the anthropologist to explore why sex ratios of all populations are not the same.

Differential mortality by sex at a site could be explained by differential investment in male and female children. In a case study by Cronk (1989) of the Mukogodo of Kenya, he determined in 1986 that for every 100 females there were 67 males in the 0-4 age group. Cronk interviewed Mukogodo mothers trying to discern an explanation for the bias in the sex ratio. Their response was that they desired equal numbers of children of both sexes. Cronk noticed the actions of the mothers were somewhat different from what they were actually stating during the interviews. The Mukogodo women would bring their female offspring to the clinic more often and they would nurse their daughters longer. There was a clear preference to rear and take special care of the female children. While Cronk did not witness any clear infanticide on the part of these parents, he did obtain a lucid understanding that the female children had better marital prospects that brought a bridewealth into the family when the daughter married (Cronk 1989).

Another factor that could affect sex ratios is differential migration. Greber (1979) states in reference to the Ohio Hopewell that differences in sex ratios may be due to marriage patterns. Greber suggests that half of the females of a society may marry outside the local unit and not be returned for burial. In turn, women marrying into the local unit may not be eligible for burial within that group's space (Greber 1979).

Differential access to the mortuary site could also be a problem that affects sex ratios. Different societies may divide the mortuary site by sex, class, and/or age. There may be burial sites that are not documented and not within the range of the known burial sites. These undocumented sites may be difficult to locate and would account for a missing portion of the population. Therefore the sex ratio may be biased. The Ohio Hopewell are again a good example. Those women according to Greber (1979) who are not returned to their own lineage, but are not eligible for burial within the lineage they married into may end up in a separate mortuary site, thus affecting sex ratios at known mortuary sites. This may account for biased sex ratios.

Stochastic affect on sex ratios could be another important factor in which there is little control. With such an effect, random departures from a 1:1 adult sex ratio may occur due to the finite nature of archaeological samples. To ascertain whether this stochastic element is important requires the use of statistical procedures. For the purposes of this research, any departure from a

1:1 sex ratio that is significant at less than or equal to an alpha level of 0.05 will be considered a non stochastic (i.e., "true" or "real") event.

Another factor affecting sex ratios is biased sex assessment. Weiss (1973) discusses the bias towards males in his analysis of 43 archaeological sites. Weiss relied on published reports that used both metrics and morphological tests to determine sex. Weiss found that of the skeletons being sexed, the questionable ones were often being assigned a sex of male.

Assessing sex ratios aides demographers in reconstructing a past population and the cultural influences that affected daily life. Evolutionary forces, cultural norms, and biased sex assessments are all factors that may explain the existence of differences in sex ratios.

The purpose of this study is to examine reports from archaeological sites from North and South America which contain skeletal samples. Examination of site reports with skeletal material may help to determine factors that affect sex ratios. This will be accomplished by examining four different factors that may help to explain the bias in sex ratios. Examination of when sites were excavated, when demographic analysis was completed, which sexing techniques were employed (visual and/or metric), and from which geographic regions the material was found could help to explain the reasons for biased sex ratios.

CHAPTER 2

LITERATURE REVIEW

The first major documentation of biased sex ratios was that done by Weiss (1973) in his landmark paper in which he accrued data from 43 archaeological sites. Weiss (1973) showed a bias toward males as a result of what he believed were the morphological differences in bone due to secondary sex characteristics. Weiss believes that morphological analysis of the pelvis is the most reliable way to determine sex. Unfortunately, the pelvis does not always preserve well and other bones must be relied on for analysis in order to determine sex.

Problems in determining the morphological characteristics of skeletal material are not the only factors that may affect sex ratios. Excavation of skeletal material may be problematic. Meticulous and thorough excavation of sites is important to obtain sufficient information in order to reconstruct past cultures. Material excavated and found in association with other cultural artifacts may help to determine unknown information about the mortuary site. Since some populations differentiate access to the mortuary site by sex, class and/or age, associated grave goods may help to determine the sex ratios of a mortuary site.

Once the material had been excavated the next important step was demographic analysis of the material. This analysis may be accomplished by using metric and/or non metric techniques. Metric analysis involves the measurement of different parts of the skeleton such as the pelvis, skull and femur. Some studies according to Weiss (Hanna & Washburn 1953; Pons 1955; Thieme and Schull 1957; and Giles and Elliott 1963) have been done in order to increase the accuracy of skeletal sexing by using the combination of measurements from a single bone or a series of measurements from different bones. Weiss emphasizes these methods must be used in reference to a population. The multivariate nature of this type of study requires the same bone from each skeleton in order to achieve maximum accuracy. Past studies involving multivariate analysis show that if the skeletal material is not complete, it can not be effectively analyzed. A more recent study by Konigsberg and Frankenberg (1992) following a method by Little and Schluchter (1985) shows that missing data is allowed in multivariate analysis and interpretable. Each method needs to have established cutoffs for males and females that are population specific as a result of the degrees of sexual dimorphism that exist for each population.

The levels of sexual dimorphism that exist in a population may affect skeletal sexing. A study by Rogers and Mukherjee (1992) made comparisons between different primate groups and humans. By observing primate behavior, theories have been suggested that primate sexual dimorphism may be an allometric response to selection for larger body size (Rogers and Mukherjee 1992). Rogers and Mukherjee (1992) give the example that if selection took 100 years to produce a one inch change in human stature it could take 6000 years to accomplish an equivalent change in sexual dimorphism, assuming that selection operated with equal force in the two cases. When Rogers and Mukherjee (1992) tested this theory on primates, they were able to show that selection can generate sexual dimorphism. Unfortunately the relationship is far too weak to account for the observed relationship between dimorphism and body size in primates. When this concept is applied to humans it makes little sense due to the fact that changes in sexual dimorphism take place so slowly that a close fit cannot be made between ecological or social circumstances of local populations. Sexual dimorphism is important and population specific. According to Rogers and Mukherjee (1992) sexual dimorphism does not change at a rapid rate and therefore when analyzing skeletal populations of roughly the same time period, anthropologists should not expect to see changes as a result of sexual dimorphism.

Weiss states that other anthropologists, such as Stewart (1954), believe in and use subjective methods as reliable indicators of sex when employed by an experienced professional. Stewart warns that measuring the pelvis should never override observational techniques that can be taught and thereafter easily applied. Stewart believes it is easier and in the long run more accurate to teach a person to sex skeletons reliably using morphological techniques as opposed to metrics. Stewart notes there could be a lot of discrepancies in interpretation as to where landmarks for measurements are located.

Non metric techniques involve the use of morphological characteristics present on bone. Many techniques have been developed to examine skeletal material and determine sex (Phenice 1969; Bass 1987; Krogman & Iscan 1986). By examining dry bone these techniques may be implemented to determine the sex of an individual.

Weiss examined studies that employed both metric and non metric techniques. Weiss found there is a tendency to call unknown specimens male and many fall into a category he calls the "larger smaller type" (Weiss 1973:

240). By this Weiss implies that when traits are displayed that are intermediate in size there is a tendency to call the intermediates male. Weiss says this is likely because the reference group is normally comprised of males. Weiss (1973) also points out that the actual skeletal series may be biased as a result of different burial customs, unrepresentative sites or poor preservation of female remains.

Weiss sampled 43 sites with an excess of males in 33 of the sites. The remaining sites showed an excess of females. Weiss states that it cannot be assumed that problems are all in the sexing techniques. A potential problem could be that the society was not made of up an equal percentage of males and females. Weiss also states that when confidence can be placed in the sexing, the problem is narrowed down to a question of sampling error or the fact that what has been found is the actual sex ratio.

Weiss concluded that there is no simple way to examine and decide which archaeological remains are reliably sexed. When a site has no morphology which can aid in determining a sex ratio then the site could be a possible candidate for a populational correction factor. The populational correction factor is a statistical method that Weiss alluded to in his article to help determine information about a population. It is important to remember that a correctional factor should only be used when other information that would normally help to determine sex is inapplicable or nonexistent.

Meindl et al. (1985) conducted a blind test of accuracy for observational sexing performed by anthropologists with above average experience in skeletal identification. The bones used were the cranium and mandible and the innominates and sacra. The purpose was to try to determine (1) if there is a correlation within sex of the crania and innominates; (2) examine possible sources of error in relation to age at death and skeletal completeness; and (3) to examine the implications of descriptive and metric determination of sex in paleodemography.

One hundred adults from the Hamann-Todd Collection with complete skulls and pelves were used. The primary assessors were Meindl and Lovejoy. Without examining the crania, they arranged complete pelves on a continuum of most male to most female using Phenice's (1969) characteristics. Other studies (Kelley 1978; Lovell 1989; Sutherland & Suchey 1991) have been completed that reinforce the accuracy of the Phenice technique. Meindl and Lovejoy coded on a simple ordinal scale with zero being most male and five being most female. The pelves were sexed without much discrepancy between assessors. Next the skulls were judged independently using the same type of scale and five morphological characteristics. Discrepancy between assessors was greater for the skull than for the pelves. Concerning skulls in which there was a disagreement, the pelves were weighted more heavily.

It was found that errors occurred only in those cases that were questionable between the assessors. No female was estimated incorrectly based on pelvic morphology. If there was a discrepancy between the pelvis and the skull, the pelvis would have been the deciding factor. As the age of the individual increases, it is difficult to determine from the cranium alone if the individual is male or female. There was no relationship between the age at death of the individual and the pelvis.

Meindl et al. (1985) determined from this study that cranial discriminant function analysis was less accurate than observational studies. The sectioning points used to metrically analyze the crania were those set up by Giles and Elliott (1963). Meindl et al. (1985) also found that sex ratios from observational studies must be estimated only from those pelves that are complete. Meindl et al. (1985) state that the number of males in a population will still most likely be underestimated while the number of females will be overestimated. This is a direct contrast of what Weiss (1973) argued in his paper. Meindl et al. (1985) believe that the reason for the difference is because the extinct pre-urban populations are biologically different from extant ethnographic populations that Weiss studied in his paper. Meindl et al. (1985) point out that uneven sex ratios happen regularly in skeletal populations as a result of uneven recovery of remains.

The conclusions of Meindl et al. (1985) and Weiss (1973) lead Meindl et al. (1985) to believe that there may be underestimates of the excess of males as a result of the demographers relying solely on cranial sexing. Meindl et al. point out that pelvic sexing can greatly reduce error. Another factor that may effect the accuracy of skeletal sexing is that extinct cemetery populations have different demographic factors in play than do extant populations. These demographic factors could account for the differences in the accuracy of the studies of Weiss (1973) and Meindl et al. (1985).

The studies by Weiss (1973) and Meindl et al. (1985) contribute theories that show biases in sex ratios may be due to morphological and metric methods of sexing the skull and pelvis. This study is not only going to examine the method of sex discrimination but also when sites were excavated, when the skeletal material was analyzed, and the region from which the material was originally found and/or excavated. By examining these ideas, new insights may be given concerning discrepancies of adult sex ratios.

CHAPTER 3

MATERIALS AND METHODS

The data used in this study have been collected from 49 protohistoric and prehistoric series from North and South America (See Table 3.1). Four factors believed to be affecting sex ratios were gathered from each report of the collection. They are as follows: (1) dates of excavation; (2) dates of demographic analyses and who performed the analyses; (3) method of sex determination used for the collection; and (4) region in which the material was found and/or excavated.

All of the information pertaining to males and females, dates of excavation, dates of demographic analysis and who performed them, and the method of discrimination used have been broken down into categories for the purposes of statistical analysis. Both the dependent and the independent variables were broken down into a binary categorical response. The independent variable is sex and the males are represented by one and the females are represented by zero.

The first independent variable is excavation (EXCAVN). For this

TABLE 3.1 SITES USED IN STUDY

SITE	MALES	FEMALES	REGION	TIME PERIOD	REFERENCE
Koniag	129	174	NW Coast	Material found or bought	Hrdlicka (1944) USNMP 94:1-174
Aleut	170	179	NW Coast	Material found or bought	Hrdlicka (1944) USNMP 94:1-174
Alaskan Rivers	135	164	NW Coast	Material found or bought	Hrdlicka (1943) USNMP 91:169-429
Seward Peninsula	115	149	NW Coast	Material found or bought	Hrdlicka (1943) USNMP 91:169-429
St.Lawrence Island	236	251	NW Coast	Material found or bought	Hrdlicka (1943) USNMP 91:169-429
Barrow District	163	174	NW Coast	Material found or bought	Hrdlicka (1943) USNMP 91:169-429
Alaskan Eskimo	129	95	NW Coast	Material found or bought	Hrdlicka (1941) USNMP 91:169-429
Point Hope	163	118	NW Coast	Material bought or found	Hrdlicka (1943) USNMP 91:169-429

SITE	MALES	FEMALES	REGION	TIME PERIOD	REFERENCE
NW Coast (FMNH)	116	72	NW Coast	Proto-historic/ early hist.	FMNH; Konigsberg pers.comm.
Jesup Expedition	320	124	NW Coast	Proto-historic	Oetteking (1930)
Pecos Pueblo	390	277	SW Site	Pre A.D. 400 - 1450	Bennett (1973)
Arizona	139	145	SW Site	Material found or bought	Hrdlicka (1931) USNMP 78:1-95
Point of Pines	134	174	SW Site	Pre A.D. 450 - 1450	Bennett (1973)
Texas Amerind	83	82	SW Site	A.D. 650-1750 A.D.	Dow (1987) Master's Thesis
Grasshopper Pueblo	85	137	SW Site	Prehistoric	Hinkes (1983)
Hawikuh	90	117	SW Site	1475-mid 1600s	Smith et al. (1966)
Casas Grandes	86	137	SW Site	A.D. 1060 - 1340 A.D.	DiPeso et al. (1974)
Ala-329	138	110	SW Site	A.D. 500 - 1700 A.D.	Jurmain (1991)
Channel Island	171	217	SW Site	Late prehistoric and historic	Walker 1986

SITE	MALES	FEMALES	REGION	TIME PERIOD	REFERENCE
Channel Island	171	217	SW Site	Late prehistoric and historic	Walker 1986
Texas Indians	270	237	SW Site	850 A.D.- 1750 A.D.	Stewart 1935
Nevada Great Basin	125	78	SW Site	Prehistoric	Stark & Brooks (1985)
Illinois Woodland-Miss Interface	293	316	Mid-West Site	A.D. 800 - 1260 A.D.	Droessler (1981)
Larson Site	108	103	Mid-West Site	A.D. 1750-1785 A.D.	Owsley & Bass (1979)
Fort Ancient	391	341	Mid-West Site	A.D. 1180	Robbins & Neumann (1972)
Dickson Mounds	150	153	Mid-West Site	A.D. 1250-1350 A.D.	Lallo et al. (1980)
Hopewell	85	78	Mid-West Site	50 B.C. - 400 A.D.	Buikstra (1976)
Adena People	147	70	SE Site	25 - 100 B.C.	Webb & Snow 1974)
Indian Knoll	283	228	SE Site	Prehistoric Archaic of E.Arch. 5302 years	Johnston & Snow (1961)

SITE	MALES	FEMALES	REGION	TIME PERIOD	REFERENCE
Carlston Annis Bt-5	108	110	SE Site	3000-4500 ybp	Mensforth (1990)
Florida	366	351	SE Site	Material bought or found	Hrdlicka (1941) USNMP 87:315-464
Nodena	80	112	SE Site	A.D. 1250 -1650 A.D.	Powell (1989)
Moundville Chiefdom	173	212	SE Site	A.D. 1050 - 1750 A.D. 3 phases	Powell (1988)
Amelia Island	43	44	SE Site	Historic	Larsen et al. (1982)
St. Catherine's Island	35	45	SE Site	500 B.C. - A.D. 600	Larson et al. (1982)
King Site	50	71	SE Site	A.D. 1535-1570 A.D.	Blakely (1988); Blakely & Matthews (1990)
Etowah	120	97	SE Site	A.D. 1500	Blakely (1977)
Irene Mound	74	75	SE Site	A.D. 1100-1400	Caldwell et al. (1941)

SITE	MALES	FEMALES	REGION	TIME PERIOD	REFERENCE
Eva & Cherry Sites	88	67	SE Site	Eva I 6000-5000 B.C. Eva II 5000-3000 B.C. Eva III 2500/1000 - 500 B.C.	Magennis (1977)
Mouse Creek Phase	163	151	SE Site	A.D. 1540-1714 A.D.	Boyd (1984)
Crow Creek Massacre	98	82	SE Site	A.D. 1100-1450 A.D.	Willey (1982)
Averbuch Site	286	251	SE Site	A.D. 1200-1400 A.D.	Berryman (1981)
Toqua (Dallas People)	115	107	SE Site	A.D. 1300-1600 A.D. ; A.D. 500 - 1700 A.D.	Parham (1982)
Estaquina	95	65	Peru, S.A.	A.D. 1350	Williams (1990)
Peru/Chile	76	49	Peru, S.A.	Not available	FMNH; Konigsberg pers.comm.
Peruvian Site	129	96	Peru, S.A.	Not available	FMNH; Konigsberg pers.comm.

SITE	MALES	FEMALES	REGION	TIME PERIOD	REFERENCE
Pacatnamu	167	137	Peru, S.A.	A.D. 600	Verrano 1987
Paloma	43	50	Peru, S.A.	5000 B.C. - 2500 B.C.	Quilter (1989)
Oaxaca	142	109	Mexico	500 B.C. - 1500 A.D.	Hodges (1987)
Molto	188	175	Canada	A.D. 500 - 800 A.D.	Molto (1983)

variable, the midpoint was taken of all the excavation dates for the 49 sites and found to be 1940. The data was broken down into binary categorical responses. The data was assigned an "A" for after 1940 or "B" for before 1940, respectively. All of the data that fit into the after 1940 category was assigned a one and all the data that fit into the before 1940 category was assigned a zero.

The second independent variable is demography (DEMOGN). This variable shows whether the material was excavated before or after Weiss' 1973 article showing the existence of a bias in skeletal sexing. All material collected and examined before Weiss' 1973 article was given the term "BW" for before Weiss and is represented by zero. All material collected and examined after Weiss' article was given the term "AW" for after Weiss and is represented by a one.

The third independent variable is method (METHODN). This variable shows whether the material was analyzed using visual or metric techniques. For the method variable, one represents the use of visual techniques and zero represents the use of metric techniques. The visual method includes all morphological techniques being used. The metric technique includes all metric and morphological techniques. Most times, if anthropologists are employing metric analysis, they are also using some morphological techniques as well.

The fourth and final independent variable is region (REGIONN). The region variable was broken down by geographic area in which the material was found and/or excavated. The seven regions are numbered consecutively as follows: (1) Canada; (2) Mexico; (3) Pacific Northwest Coast; (4) Midwestern United States; (5) Peru; (6) Southeastern United States; and (7) Southwestern United States.

The data was analyzed on the VAX/VMS Mainframe at the University of Tennessee, Knoxville, using the statistical package SAS, Version 6. Statistical techniques designed to work with binary response data were implemented. The procedure Categorical Data Modeling (CATMOD) was used to analyze the data since other standard regression models do not perform well when the data is composed of binary responses (Afifi and Clark 1984; Aldrich and Nelson 1984).

CATMOD analyzes data through the use of contingency tables. A contingency table allows for summarizing data from two or more qualitative variables. CATMOD analyzes the data set and takes into account all the various possibilities that could occur for the given variables. The results of the these computations will produce the contingency tables.

The CATMOD procedure outputs a table of maximum likelihood parameter estimates. The estimates from this table show the direction of effect for a given variable. Chi-square values are also shown here and examine all independent variables as well as controlling for the dependent variables in the model. The chi-square is important in helping to determine the accuracy of the ideas being tested. Each variable has an associated p-value that determines the significance of a given variable.

CHAPTER 4

RESULTS

Logistic regression analysis procedures were used to examine how each of the independent variables affected the dependent variable sex. The independent variables are as follows: (1) excavation (sites excavated before or after 1940); (2) demography (sites examined before or after Weiss' article); (3) method (sites in which visual or metric sexing analysis was completed); and (4) region (where the material was found). The following are the results of this study.

The Categorical Data Modeling procedure (CATMOD) produced a total frequency of 14512 skeletons from 49 sites. One-Way Frequencies were denoted for the dependent variable Y (no_males) and the independent variables EXCAVN, DEMOGN, METHODN, and REGIONN. Each variable has a value which has been assigned to each of the categories. The One Way Frequency Table shows how many of the total sample fell into each of the categories (See Table 4.1). A Population Profile was produced by the

TABLE 4.1

CATMOD PROCEDURE

Response: Y	Response Levels (R)=2
Weight Variable: COUNT	Populations (S)=21
Data Set: B	Total Frequency (N)=14512
Frequency Missing: 0	Observations (Obs)=98

ONE-WAY FREQUENCIES

Variable	Value	Frequency
Y	0	7036
	1	7476
EXCAVN	0	8125
	1	6387
DEMOGN	0	7325
	1	7187
METHODN	0	4814
	1	9698
REGIONN	1	363
	2	251
	3	3176
	4	2018
	5	907
	6	4275
	7	3522

CATMOD procedure. The Population Profiles Table takes into account every possible combination of the variables involved in the analysis. CATMOD then puts the data into a table (See Table 4.2). For this data set, there was a total of 56 possible combinations of the independent variables in which 21 possible combinations actually exist. A frequency count is shown for each possible combination. The Response Profiles here are needed to interpret the Response Probabilities Table.

The Response Probabilities Table (See Table 4.3) represents the 21 combinations with the response number zero for females and one for males. This table shows the percentage of females and males for each combination. In most cases there is a larger percentage of males as opposed to females.

The Maximum Likelihood Analysis shows an iteration table (See Table 4.4). This is a step the program goes through in order to calculate the maximum likelihood estimates. This table shows how many iterations CATMOD had to go through in order to output the parameter estimates. The Maximum-Likelihood Analysis of Variance Table (See Table 4.5) shows the breakdown of each of the independent variables as well as the

TABLE 4.2

POPULATION PROFILES

Sample	EXCAVN	DEMOGN	METHODN	REGIONN	Sample Size
1	0	0	0	2	251
2	0	0	0	6	825
3	0	0	1	3	2988
4	0	0	1	4	732
5	0	0	1	5	225
6	0	0	1	6	1083
7	0	0	1	7	491
8	0	1	0	3	188
9	0	1	0	5	125
10	0	1	0	6	550
11	0	1	1	7	667
12	1	0	1	7	730
13	1	1	0	1	363
14	1	1	0	4	303
15	1	1	0	5	93
16	1	1	0	6	1038
17	1	1	0	7	1078
18	1	1	1	4	983
19	1	1	1	5	464
20	1	1	1	6	779
21	1	1	1	7	556

RESPONSE PROFILES

Response	Y
1	0
2	1

TABLE 4.3

RESPONSE PROBABILITIES

Sample	Response 1(Female)	Number 2(Male)
1	0.43426	0.56574
2	0.45939	0.54061
3	0.47791	0.52209
4	0.46585	0.53415
5	0.42667	0.57333
6	0.45799	0.54201
7	0.53360	0.46640
8	0.38298	0.61702
9	0.39200	0.60800
10	0.54000	0.46000
11	0.41529	0.58471
12	0.51233	0.48767
13	0.48209	0.51791
14	0.50495	0.49505
15	0.53763	0.46237
16	0.49326	0.50674
17	0.56957	0.43043
18	0.51272	0.48728
19	0.43534	0.56466
20	0.46470	0.53530
21	0.51079	0.48921

TABLE 4.4

MAXIMUM-LIKELIHOOD ANALYSIS

Iteration	Sub Iteration	-2 Log Likelihood	Convergence Criterion	Parameter Estimates 1	2
0	0	20117.904	1.0000	0	0
1	0	20053.857	0.003184	-0.0967	-0.0886
2	0	20053.857	4.3825E-8	-0.0971	-0.0888
3	0	20053.857	2.948E-16	-0.0971	-0.0888

Parameter Estimates

Iteration	3	4	5	6	7
0	0	0	0	0	0
1	0.0488	0.0726	-0.0873	-0.1990	0.0955
2	0.0489	0.0727	-0.0872	-0.2001	0.0961
3	0.0489	0.0727	-0.0872	-0.2001	0.0961

Parameter Estimates

Iteration	8	9	10
0	0	0	0
1	0.1147	-0.1104	0.0203
2	0.1153	-0.1114	0.0205
3	0.1153	-0.1114	0.0205

TABLE 4.5

ANALYSIS OF MAXIMUM-LIKELIHOOD ESTIMATES

Effect	Parameter	Estimate	Standard Error	Chi-Square	Prob
INTERCEPT	1	-0.0971	0.0276	12.38	0.0004
EXCAVN	2	-0.0888	0.0247	12.94	0.0003
DEMOGN	3	0.0489	0.0250	53.68	0.0550
METHODN	4	0.0727	0.0222	10.76	0.0010
REGIONN	5	-0.0872	0.0970	0.81	0.3684
	6	-0.2001	0.1170	52.90	0.0885
	7	0.0961	0.0470	24.14	0.0420
	8	0.1153	0.0490	75.38	0.0204
	9	-0.1114	0.0650	12.93	0.0869
	10	0.0205	0.0380	10.29	0.5900
	11	0.1637	0.0396	17.09	0.0001

intercept value. Each is associated with a p-value. Significance is determined in this study by an alpha level that is equal to or less than 0.05. The breakdown of each of the independent variables is as follows.

The intercept of the model has a negative direction of effect (-0.0971) with a significant p-value of 0.0004. This means that overall there are too few females in the skeletal series examined for this research.

The excavation variable consisted of whether or not the sites being analyzed for this study were excavated before or after 1940. The direction of effect for the excavation variable (-0.0888) is negative. This means that there are even less females for the earlier sites (i.e. before 1940) than for the later sites (i.e. after 1940). This effect is significant, with a p-value of 0.0003.

The demography variable consisted of whether or not the material was analyzed before or after Weiss' 1973 article. The direction of the effect for the demography variable (0.0489) is positive. This means that there is less of a deficit of females for those sites analyzed after Weiss' 1973 article (i.e. more existing skeletons are actually being categorized as female than before Weiss' article). This effect is almost significant with a p-value of 0.0550.

The method variable consisted of whether or not the assessor was using visual or metric techniques in order to assess the sex of the skeletal material.

The direction of the effect of the method variable (0.0727) is positive. This means that there is less of a deficit of females for using the metric method (i.e. more skeletons are being sexed as females as a result of using metric techniques). This effect is significant, with a p-value of 0.0010.

The region variable consisted of seven different geographic regions from which the material was originally excavated. The direction of effect of the sex ratio is broken down by region. The effect of Region 1 (Canada) is negative (-0.0872). This means there are few females in Region 1. This effect is not significant, with a p-value of 0.3684.

The direction of effect for Region 2 (Mexico) is negative (-0.2001). This means there are few females in Region 2. The effect is not significant, with a p-value of 0.0885.

The direction of effect for Region 3, the Pacific Northwest Coast (0.0961) is positive. This means there is less of a deficit of females (i.e. the ratio is closer to 1:1). This effect is significant, with a p-value of 0.0420. The direction of effect for Region 4, the Midwestern United States, (0.1153) is positive. This value means that there is less of a deficit of females (i.e. more skeletons being sexed as females at Region 4). The effect is significant, with a p-value of 0.0204.

The direction of effect for Region 5, the Peruvian sites, (-0.1114) is negative. This means there are few females at Region 5. The effect is not significant, with a p-value of 0.0869.

The direction of effect for Region 6, the Southeastern United States, (0.0205) is positive. This means there is less of a deficit of females at Region 6 (i.e. more females at Region 6). The effect is not significant, with a p-value of 0.5900.

The direction of effect for Region 7, the Southwestern United States, is positive (0.1637). This means there is an excess of females for this region. The effect is significant, with a p-value of 0.0001.

The Correlation Matrix of the Maximum-Likelihood Estimates (See Table 4.6) determined if any collinearity among X variables existed. Parameter estimates may be redundant. If a cell is examined, for example (2,5) the same number that appears for (2,5) should appear in the cell (5,2). The correlation matrix shows if additional variables are contributing any supplemental information. If the correlations between parameter estimates are greater than

TABLE 4.6

CORRELATION MATRIX
OF THE MAXIMUM-LIKELIHOOD ESTIMATES

	1	2	3	4	5
1	1.0000000	-0.0641612	0.0775253	0.0577886	0.2946734
2	-0.0641612	1.0000000	-0.5662581	-0.0595370	0.1378070
3	0.0775253	-0.5662581	1.0000000	0.3472898	0.0169397
4	0.0577886	-0.0595370	0.3472898	1.0000000	-0.1691421
5	0.2946734	0.1378070	0.0169397	-0.1691421	1.0000000
6	0.4648085	-0.0611029	-0.1815602	-0.2651568	-0.2732959
7	-0.4255384	-0.2407626	-0.0807863	0.2461456	-0.3617065
8	-0.3286982	0.0738724	0.1290710	0.3213311	-0.2541891
9	-0.0479275	-0.0074045	0.1770927	0.2154527	-0.2407215
10	-0.5898153	-0.0861337	0.0443712	-0.0873614	-0.2489157

	6	7	8	9	10
1	0.4648085	-0.4255384	-0.3286982	-0.0479275	-0.5898153
2	-0.0611029	-0.2407626	0.0738724	-0.0074045	-0.0861337
3	-0.1815602	-0.0807863	0.1290710	0.1770927	0.0443712
4	-0.2651568	0.2461456	0.3213311	0.2154527	-0.0873614
5	-0.2732959	-0.3617065	-0.2541891	-0.2407215	-0.2489157
6	1.0000000	-0.2957137	-0.4236087	-0.3691822	-0.3538804
7	-0.2957137	1.0000000	0.1482992	-0.0217970	0.2322726
8	-0.4236087	0.1482992	1.0000000	0.0302800	0.1451059
9	-0.3691822	-0.0217970	0.0302800	1.0000000	-0.0222358
10	-0.3538804	0.2322726	0.1451059	-0.0222358	1.0000000

.7 then there are potential problems among the independent variables (Aldrich and Nelson 1984). Since all values are less than .7 in the Correlation Matrix, there is no collinearity problem with this model.

CHAPTER 5

DISCUSSION AND CONCLUSION

The results of the logistic regression procedure showed that the date of excavation, date of analysis, method of skeletal sexing being used, and the region the material came from were all important factors in determining a bias in sex ratios.

The following outcomes were ascertained as a result of this study. Overall, the model shows a bias towards males. Each of the independent variables has been broken down to show the effects on sex ratios. The first analysis is that of the excavation variable. This variable shows less females for earlier sites (i.e meaning those sites excavated before 1940). A possible explanation for the lack of representation of females at these sites before 1940 may be that some earlier excavations did not take all of the skeletal material out of the field. This may be illustrated by some of the bigger sites which have very large numbers of skeletons. When the analysis is completed the number of skeletons actually examined is much smaller than the original sample. Another possible interpretation for the lack of females before 1940 may be explained by Neumann (1952) and his ideas concerning racial typologies. Neumann believed that males were better able to express racial attributes. As a result of this, it is possible that the male skeletons were being taken out of the field to be analyzed in the laboratory while leaving the more gracile females in the field. This may also have created a biased sex assessment.

Analysis of the demography variable shows more skeletons being sexed as females after Weiss' article. Possible explanations for this may be that after 1973 anthropologists became aware of a problem with sex ratios. As a result of Weiss' article, anthropologists may now be employing sexing techniques with greater accuracy. Along with this greater awareness, anthropologists are not just assuming that the skeletal material is male if they are unsure of the sex after a thorough examination.

Analysis of the methods variable shows that by using metric techniques there are more skeletons being sexed as females. Possible explanations for this theory are that sexing crania involves methods that rely on characteristics present in males and not in females. Problems here could be the result of the "mind's eye rounding up," meaning that when examining material that is marginal the eye may see more male characteristics. Likewise, when sexing the pelvis using Phenice's characteristics (1969) the anthropologist relies on criteria that are present in females and absent in males. Once again the mind's eye may round up and throw off estimates. Through the use of Phenice's techniques this may account for more skeletons being sexed as females.

Analysis of the region variable is broken down by each individual area. Canada (Region 1), Mexico (Region 2), Peru (Region 5) and the Southeastern United States (Region 6) show non significant p-values at 0.05 and will not be discussed further. The Pacific Northwest Coast (Region 3), Midwestern United States (Region 4), and Southwestern United States (Region 7) all have significant p-values at 0.05 and will be discussed in further detail.

The Pacific Northwest Coast overall shows an increase in the number of female skeletons. A possible explanation for the increase in females is difficult to ascertain. It is known that most material from the Pacific Northwest Coast was gathered (i.e. surface collections or bought) by Boas and his assistants (Cole 1985). The lack of analytical techniques that would normally be used during the excavation of an archaeological site brings into question the accuracy of his findings.

The Midwestern United States overall shows an increase in the number of female skeletons. A possible explanation for the rise in female skeletal material in this region may be that all skeletal material is now coming out of the field, not just the male material as was defined by Neumann (1952).

The Southwestern United States shows an excess of females. Possible explanations for this may be differential access to the mortuary site. Burial sites may be allocated based on class, sex and/or gender. Also, males may have gone off to fight wars or to hunt for food. These males may have been killed while away from home and as a result buried in another location. The people of the Southwestern region may have had little dimorphism which would have also biased the sex ratios.

CONCLUSION

This study shows that biased sex ratios are not as prevalent today as they were when Weiss completed his study in 1973. This may be the result of a new generation of analysts coming of age in the late 1960's and early 1970's who seem more concerned about employing sexing techniques with greater accuracy. The emergence of life tables and other demographic tools that require accurate sexing may have also been motivation for the greater precision. Techniques used to determine sex today have also changed directions. Phenice (1969) came out with his study that emphasized characteristics present in females. Before this study skeletal collections were sexed using techniques based on male characteristics. This shift in techniques may have also contributed to a reduction in the bias.

As a result of the new awareness and care being employed when sexing skeletal material, anthropologists may have become more straightforward about ambiguities that are incurred when determining the sex of skeletal material. Further study in the direction of analyzing the lineage of assessors and the schools of thought surrounding training may also provide insight into biased sex ratios. Examination of reanalyzed collections may also show changes that have occurred in skeletal sexing. Further study into these theories are the next likely steps towards understanding biased sex ratios.

REFERENCES CITED

REFERENCES CITED

Afifi AA and Clark V

1984 Computer-Aided Multivariate Analysis. Belmont, CA: Wadsworth, Inc.

Aldrich JH and Nelson FD

1984 Linear Probability, Logit, and Probit Models. Sage University Paper series on Quantitative Applications in the Social Sciences, 07-045. Beverly Hills and London: Sage Publications.

Bass WM

1987 Human Osteology. A Laboratory and Field Manual of The Human Skeleton. (3rd Edition) Missouri Archaeological Society. Columbia, Missouri.

Bennett K

1973 The Indians of Point of Pines, Arizona. A Comparative Study of Their Physical Characteristics. Anthropological Papers of The University of Arizona No 23. University of Arizona Press, Tucson, Arizona.

Berryman HE

1981 The Averbuch Skeletal Series: A Study of Biological and Social Stress At A Late Mississippian Period Site From Middle Tennessee. Ph.D. diss., Department of Anthropology, The University of Tennessee, Knoxville.

Blakely RL

1977 Biocultural Adaptation In Prehistoric America. Southern Anthropological Society Proceedings, No. 11. Gwen Kennedy Neville, Series Editor. The University of Georgia Press, Athens.

Blakely RL

1988 The King Site. Continuity and Contact in Sixteenth-Century Georgia. The University of Georgia Press, Athens and London.

Blakely RL and Mathews DS
1990 Bioarchaeological Evidence For A Spanish-Native American Conflict in The Sixteenth-Century Southeast. American Antiquity 55: 718-744.

Boyd D
1984 A Biological Investigation of Skeletal Remains from the Mouse Creek Phase and A Comparison With Two Late Mississippian Skeletal Populations From Middle and East Tennessee. Master's Thesis, Department of Anthropology, The University of Tennessee, Knoxville.

Buikstra JE
1976 Hopewell in The Lower Illinois Valley. A Regional Study of Human Biological Variability and Prehistoric Mortuary Behavior. Northwestern University Archaeological Program. Scientific Papers, No. 2.. Evanston, Illinois.

Caldwell J and McCann C
1941 Irene Mound Site Chatham County, Georgia. Athens, GA. The University of Georgia Press.

Cole D
1985 Captured Heritage. The Scramble for Northwest Coast Artifacts. University of Washington Press.

Cronk L
1989 From Hunters to Herders: Subsistence Change as a Reproductive Strategy among the Mukogodo. Current Anthropology 30: 224-234.

DiPeso CC, Rinaldo JB, and Fenner GJ
1974 Casas Grandes. A Fallen Trading Center of The Gran Chichimeca. The Amerind Foundation, Inc. Dragoon. Northland Press, Flagstaff. Volumes 1, 3 and 8.

Dow LA
1987 The Genetic Affinities and Adaptive Success of Three Groups of Late Prehistoric Amerindians From Texas. Master's Thesis, University of Texas, Austin.

Droessler J
1981 Craniometry and Biological Distance. Biocultural Continuity and Change at the Late Woodland-Mississippian Interface. Center For American Archeology at Northwestern University, Evanston Il.

Giles E and Elliott O
1963 Racial Identification from Cranial Measurements. Journal of Forensic Science 7: 147-157.

Greber N
1979 Variations in Social Structure of Ohio Hopewell Peoples. American Antiquity. 46: 566-571

Hanna RE and Washburn SL
1953 The Determination of the Sex of Skeletons, As Illustrated By a Study of the Eskimo Pelvis. Human Biology 25: 21-25.

Hinkes MJ
1983 Skeletal Evidence of Stress in Subadults: Trying to Come of Age at Grasshopper Pueblo. Ph.D. diss., University of Arizona.

Hodges DC
1987 Health and Agricultural Intensification In The Prehistoric Valley of Oaxaca, Mexico. American Journal of Physical Anthropology 73: 323-332.

Hrdlicka A
1931 Catalog Of Human Crania In The United States National Museum Collections. In Proceedings of The United States National Museum. Smithsonian Institution. Government Printing Office, Washington, D.C. 78: 1-95.

Hrdlicka A

1941 Catalog of Human Crania In The United States National Museum Collections: Indians of The Gulf States. In Proceedings of The United States National Museum. Smithsonian Institution. Government Printing Office. Washington, D.C. Vol 87: 315-464.

Hrdlicka A

1943 Catalog of Human Crania In The United States National Museum Collections: Eskimo In General. In Proceedings of The United States National Museum. Smithsonian Institution. Government Printing Office, Washington, D.C. 91: 169-429.

Hrdlicka A

1944 Catalog of Human Crania In The United States National Museum Collections: Non-Eskimo People of the Northwest Coast, Alaska, and Siberia. In Proceedings of The United States National Museum. Smithsonian Institution. Government Printing Office, Washington D.C. 94: 1-174.

Johnston FE and Snow CE

1961 The Reassessment of The Age and Sex of The Indian Knoll Skeletal Population: Demographic and Methodological Aspects. American Journal of Physical Anthropology 19: 237-244.

Jurmain RD

1991 Paleoepidemiology of Trauma in a Prehistoric Central California Population. In DJ Ortner and AC Aufderheide (eds): Human Paleopathology. Current Syntheses and Future Options. Smithsonian Institution Press. Washington and London. pp 241-248.

Kelley MA

1978 Phenice's Visual Sexing Technique for the Os Pubis: A Critique. American Journal of Physical Anthropology 48: 121-122.

Konigsberg LW and Frankenberg SR
1993 Missing Skulls and Missing Data in Ohio Hopewell. Paper presented at the 58th Annual Meeting of the Society for American Archaeology.

Konigsberg LW and Cole GC
1987 Improving Accessibility and Conditions for Preservation of the Human Skeletal Collection (NSF Grant BNS-8507828), Technical Summary. Submitted to the National Science Foundation. Personnel Communication.

Krogman WM and Iscan MY
1986 The Human Skeleton in Forensic Medicine. (Second Edition) Springfield IL: Charles C. Thomas Publishers.

Lallo J, Rose JC, and Armelagos GJ
1980 An Ecological Interpretation of Variation In Mortality Within Three Prehistoric American Indian Populations From Dickson Mounds. In DC Browman (ed): Early Native Americans: Prehistoric Demography, Economy, and Technology. Paris: Mouton. pp 203-238.

Larson, CP and Thomas DH
1982 The Anthropology of St. Catherines Island 3. Prehistoric Human Biological Adaptation. Anthropological Papers of The American Museum of Natural History. New York. Vol 57: Part 3.

Little RJA and Schluchter MD
1985 Maximum Likelihood Estimation for Mixed Continuous and Categorical Data with Missing Values. Biometrika 72: 497-512.

Lovell NC
1989 Test of Phenice's Technique for Determining Sex from the Os Pubis. American Journal of Physical Anthropology 79: 117-120.

Magennis AL
1977 Middle and Late Archaic Mortuary Patterning: An Example From The Western Tennessee Valley. Master's Thesis, Department of Anthropology, University of Tennessee, Knoxville.

Meindl RS, Lovejoy CO, Mensforth RP and Carlos LD
1985 Accuracy and Direction of Error in the Sexing of the Skeleton: Implications for Paleodemography. American Journal of Physical Anthropology 68: 79-85.

Mensforth RP
1990 Paleodemography of the Carlston Annis (Bt-5) Late Archaic Skeletal Population. American Journal of Physical Anthropology 82: 81-99.

Molto JE
1983 Biological Relations of Southern Ontario Woodland Peoples: The Evidence of Discontinuous Cranial Morphology. National Museum of Man Archaeological Survey of Canada. Paper No. 117 National Museum of Canada. Ottawa.

Neumann GK
1952 Archeology and Race in the American Indian. In JB Griffin (ed): Archeology of Eastern United States. The University of Chicago Press. Chicago.

Oetteking B
1930 The Jesup North Pacific Expedition Edited by Franz Boas. Memoir of The American Museum Of Natural History New York. Volume XI. EJ Brill Ltd Leiden.

Owsley DW and Bass WM
1979 A Demographic Analysis of Skeletons from The Larson Site (39WW2) Walworth County, South Dakota: Vital Statistics. American Journal of Physical Anthropology 51: 145-154.

Parham KR
1982 A Biocultural Approach To The Skeletal Biology Of The Dallas People From Toqua. Master's Thesis, Department of Anthropology, The University of Tennessee, Knoxville.

Phenice TW
1969 A Newly Developed Visual Method of Sexing the Os Pubis. American Journal of Physical Anthropology 30: 297-302.

Pons J
1955 The Sexual Diagnosis of Isolated Bones of the Skeleton. Human Biology 27: 12-21.

Powell ML
1988 Status and Health in Prehistory. A Case Study of the Moundville Chiefdom. Smithsonian Institution Press. Washington and London.

Powell ML
1989 The People of Nodena. In DF Morse (ed.): Nodena. An Account of 90 Years of Archeological Investigation in Southeast Mississippi County, Arkansas. Arkansas Archeological Survey Research Series No.30. Fayetteville, Arkansas. pp 65-95.

Quilter J
1989 Life and Death at Paloma. Society and Mortuary Practices In A Preceramic Peruvian Village. University of Iowa Press, Iowa City.

Robbins LM and Neumann GK
1972 The Prehistoric People of The Fort Ancient Culture Of The Central Ohio Valley. Anthropological Papers Museum of Anthropology No. 47. University of Michigan, Ann Arbor, Michigan.

Rogers AR and Mukherjee A
1992 Quantitative Genetics of Sexual Dimorphism in Human Body Size. Evolution 46: 226-234.

SAS Institute Incorporated
1989 SAS/STAT User's Guide, Version 6, Fourth Edition, Volumes 1 and 2, Cary, NC: SAS Institute Inc.

Sieff DF
1990 Explaining Biased Sex Ratios in Human Populations. A Critique of Recent Studies. Current Anthropology 31: 25-48.

Smith W, Woodbury RB, and Woodbury NFS
1966 The Excavation Of Hawikuh By Frederick Webb Hodge 1917-1923. New York Museum Of The American Indian Heye Foundation. Printed in Germany at JJ Augustin, Gluckstadt.

Stark C and Brooks ST
1985 A Survey of Prehistoric PaleoPathology In The Nevada Great Basin. In CF Merbs and RJ Miller (eds): Health and Disease in the Prehistoric Southwest. Arizona State University Papers. Anthropological Research Papers No 34: 65-78.

Stewart TD
1935 Skeletal Remains From Southwestern Texas. American Journal of Physical Anthropology 20: 213-231.

Stewart TD
1954 Sex Determination of the Skeleton By Guess and By Measurement. American Journal of Physical Anthropology 12: 385-392.

Sutherland LD and Suchey JM
1991 Use of the Ventral Arc in Pubic Sex Determination. Journal of Forensic Sciences. 36: 501-511

Thieme FP and Schull WJ
1957 Sex Determination from the Skeleton. Human Biology 29: 242-273.

Verrano JW
1987 Cranial Microvariation at Pacatnamu: A Study of Cemetery Population Variability. Ph.D. diss., Department of Anthropology, University of California, Los Angeles.

Walker PL
1986 Porotic Hyperostosis in a Marine-Dependent California Indian Population. American Journal of Physical Anthropology 69: 345-354.

Webb WS and Snow CE
1974 The Adena People. The University Of Tennessee Press, Knoxville.

Weiss KM
1973 On the Systematic Bias in Skeletal Sexing. American Journal of Physical Anthropology 37: 239-250.

Willey P
1982 Osteology Of The Crow Creek Massacre. Ph.D. diss., Department of Anthropology, The University of Tennessee, Knoxville.

Williams SR
1990 The Skeletal Biology of Estuquina: A Late Intermediate Period Site In Southern Peru. Ph.D. diss., Department of Anthropology, Northwestern University.

VITAE

Karen Elizabeth Bone was born in Upstate New York and attended elementary and high school there. Karen received her Bachelor of Arts degree in Anthropology in 1990 from the State University of New York at Potsdam. She is also certified to teach elementary school in New York State. In August of 1990, she matriculated at the University of Tennessee, Knoxville and received her Master of Arts degree in Anthropology in 1993.

While at the University of Tennessee, Karen volunteered her time working in the Forensic Anthropology Center under the direction of Dr. William M. Bass. Karen has been a member of the American Association of Physical Anthropologists since 1991 and is interested in all facets of physical anthropology but especially those involving skeletal biology and forensics.